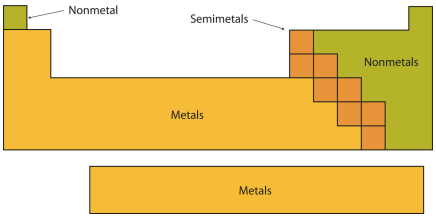
DSHS
Physical Science

Name_____
Period_____

METALS



On the periodic table, all but one of the elements
To the left of the zigzag stair step are called **metals.**
Hydrogen (H) is the only exception; it is considered a non-metal. Metals have similar properties. They are usually hard, shiny, have high densities and high melting points. Most metals are solids at room temperature. Mercury (Hg) is a liquid at room temperature (25 degrees Celsius, 77 degrees Fahrenheit). Cesium (Cs), francium (Fr), gallium (Ga) all melt at temperatures slightly warmer than room temperature. No metals are gases at room temperature. Because solids metals are malleable, they can be hammered out into sheets or bent into shapes without breaking. They are also ductile, which means they can be pulled and stretched into thin wires. Metals are generally good conductors of both heat and electricity.

As you learned most metals have one, two or three electrons in their outer shell or highest occupied energy level. These electrons are called valence electrons and they are held loosely. Metals tend to give up valence electrons to form ionic bonds with other elements. However, neutral metal atoms can form a special kind of bond among themselves, called a metallic bond. In metals, the loosely held valence electrons form a kind of could around the atoms. The atoms share the electrons which makes the metallic bond. In metals, the valence electrons can move about freely. When an electric current or heat touches a metal, the electrons can move away from the atoms that they are nearest. The moving electrons can pass or conduct electrical current or heat from one atom to the next. The loosely held valence electrons allow atoms to slide past each other. That is why a metal can be hammered or stretched without breaking. In a nonmetal, valence electrons are more tightly by the atoms. Atoms in nonmetals cannot slide past each other easily. When a solid nonmetal is hammered or stretched, its atoms are pushed closer to each other. The atoms repel each other, and the non-metal breaks.

Review Questions

Review the information you have been given about metals. Read the following questions and fill in the blanks **to the right** using the words below, not all answers will be used.

brittle	liquid	three	helium	malleable
hydrogen	nonconductors	metallic	conductors	ductile

1. A substance that can be stretched into wires is called _____a_____ a._____

2. Although most metals are not _____b_____ at room temperature, the element mercury (Hg) is. b._____

3. Metals are good _____c_____ of heat and electricity c._____

4. The special bond between atoms of metals is called a _____d_____ bond. d._____

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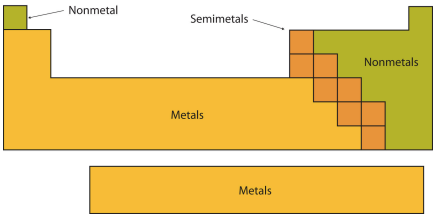
NON-METALS



The non-metals are the group of elements to the right of the zigzag stair step on the periodic table, plus hydrogen. Non-metals have fewer properties in common than metals. Their most common characteristic is that they are not metal, They are not malleable, ductile or shiny, and they are not good conductors of heat and electricity. In fact they are used as insulators. At room temperature, some are solids, one is liquid and some are gases.

Most non-metals have five to eight electrons in their valence shell or highest occupied energy level. (Boron, carbon and silicon are exceptions). As a result non-metals, hold their valence electrons tightly. Some non-metals form covalent bonds by sharing electrons. The atoms of most non-metals accept electrons, become ions and form ionic bonds. Non-metals are good insulators because they hold their valence electrons so tightly.

The noble gases (8A or group 18) are a special group of non-metals. All but one of these gases has eight valence electrons. Helium (He) is the exception and only has two electrons in first shell or energy level. This electron arrangement makes these atoms very stable. The noble gases do not interact easily with other elements or even themselves. Thus, the are considered "safe" gases. They are used in advertising signs (neon and argon), balloons (helium) and even blimps (helium).

Review Questions

Review the information you have been given about non-metals. Read the following questions and fill in the blanks **to the right** using the correct answer.

1. Which of the following is a property of non-metals? a._____
a) malleable b) nonconductor c) ductile d) shiny

2. Which of the following elements is a non-metal? b._____
a) Na b) Br c) Mg d) Li

3. Noble gas used in advertising signs is c._____
a) Xe b) He c) Kr d) Ne

4. Helium is the noble gas with __d__ valence electrons. d._____
a) three b) two c) five d) four

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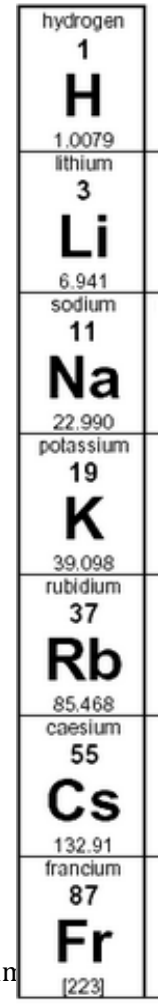
ALKALI METALS



The alkali metals are members of group 1A (1) or the periodic table. They include lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs) and francium (Fr). These elements are very good conductors of heat and electricity. They are soft and can be cut easily with a knife. Group 1A (1) elements have low melting points and also have low densities.

The alkali metals are the most chemically reactive metals. They are so reactive that they are not found freely in nature. Pure samples of alkali metals are stored in oil so that they cannot react with oxygen or water in the air. Alkali metals usually form ionic compounds. Each alkali metal has one electron in its valence shell. This electron is loosely held which makes it easy for alkali metals to combine with non-metals to form a pair of ions. These ions then form an ionic compound.

The ions of alkali metals can be identified by using a flame test: a small Amount of an unknown metal in an ionic compound is heated in a flame. The color of the flame indicates which metal ion is present. For example, sodium's flame is bright yellow and potassium's is pale pink.

Alkali metals are used to produce chemicals, metals, soap, glass, Ceramics, petroleum products, and textiles. Cesium and rubidium are used in photoelectric cells. Potassium – in the form of potassium carbonate, or potash – is used as a plant fertilizer. Sodium, combined with chlorine to form sodium chloride (table salt) is what makes the ocean salty. Potassium and sodium are ions that are essential to life for most organisms.

Review Questions

Review the information you have been given about metals. Read the following questions and fill in the blanks **to the right** using the words below, not all answers will be used.

cesium	heat	one	temperature	color	ionic
potassium	three	electricity	molecular	sodium	water

1. Alkali metals are very good conductors of ___a___ & ___b___ a._____ b._____

2. Alkali metals are extremely reactive and found in___c___ compounds. c._____

3. Each atom in the alkali metals has ___d___ valence electron in its outer shell and can be identified using a flame test in which each element produces a different___e___ . d._____ e._____

4. ___f___ and___g___ are necessary for life. f._____ g._____

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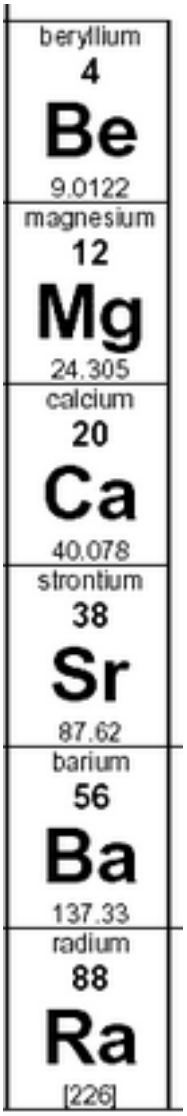
ALKALINE EARTH METALS



The alkaline earth metals are members of group 2A (2) of the periodic table. They include beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), and radium (Ra). Their melting points and boiling points are higher than the alkali metals.

Like the alkali metals, the alkaline earth metals are very chemically reactive. They too are never found freely in nature. Alkaline earth metals usually form ionic compounds. Each atom has two valence electrons that are transferred to other elements to form ions.

Beryllium is perhaps the best known as part of the mineral beryl. Two precious gems, emerald and aqua marine contain Beryllium. It is a light and rigid metal also used in computers, gyroscopes, and nuclear reactors. Magnesium is used in aircraft, spacecraft, ad in high intensity flashbulbs.

Calcium is the fifth most abundant element in the earth's crust. Some forms of calcium such as calcium oxide or lime have been known for many centuries. However, pure calcium metal was not discovered until 1808. Calcium is an essential part of bones and teeth.

Calcium, strontium and barium have very similar chemical properties. They have similar industrial uses. Strontium is much less common and costs more. One special use of strontium is in fireworks, it burns with a brilliant red color.

Barium and radium compounds have special medical uses. Barium is used in the study of digestive disorders. Radium, found in nature in uranium ore is radioactive and has been used in cancer therapy.

Review Questions

Review the information you have been given about metals. Read the following questions and fill in the blanks **to the right** using the words below, not all answers will be used.

Barium	calcium	magnesium	strontium	lower
Beryllium	higher	one	two	uranium

Group 2A elements have ___a___ melting points than group 1A.
Alkaline earth metals have ___b___ valence electrons. Emerald and
Aquamarine contain the element ___c___. ___d___ is the fifth most
abundant element in the earths crust. A flame test for ___e___ yields a
brilliant red color. Radium is found in___f___ ore in nature.

a._____
b._____
c._____
d._____
e._____
f._____

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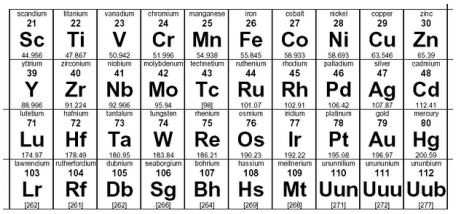
TRANSITION METALS



The transition metals are in groups 1B-8B or groups 3-12 on the periodic table. They include metals that are common such as copper, iron, nickel, zinc, silver and gold. Most transition metals are hard and somewhat brittle. They have high melting points. They form many alloys with one another. Many have a characteristic color by which the pure metals and alloys can be recognized. Most have one or two electrons in their valence shell or highest occupied energy level. Many form more than one kind of ion with charges. For example iron forms charges of +2 or +3.

The properties of the transition metals vary widely. But each element is similar to is nearest neighbors on the periodic table. Most transition metals have a grayish color (silver), but some are yellow (gold) and red (copper). A few have low melting points including mercury but many have high melting points.

The many industrial uses of transition metals range from medicines to ornaments, from aircraft parts to thermometers. Three examples to consider are gold (Au), palladium (Pd) and tantalum (Ta). Pure gold is used in the electronics industry, gold salts are used to treat arthritis. Palladium is less familiar but is used in dentistry, and used to make watches and surgical instruments. Tantalum has uses that range from nuclear reactors and missiles to parts of camera lenses. Tantalum is used for surgical appliances and has an unusual ability to resist attack. It will not break down or cause irritation to the human body.

Review Questions

Review the information you have been given about metals. Read the following questions and fill in the blanks **to the right** using the words below, not all answers will be used.

Colors	low	osmium	tantalum	tungsten	high
Octagonal	cubic	palladium	titanium	shape	mercury

Many transition elements have characteristic ___a___ by which pure forms of the element and alloys are known. Some have___b___ melting points. ___c___ is a transition metal used to manufacture watches. ___d___ is used to make camera lenses. ___e___ has an unusual ability to resist chemical attack.

a._____
b._____
c._____.
d._____
e._____

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LANTHANIDE AND ACTINIDE METALS

*Lanthanide series	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
**Actinide series	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

The lanthanides and actinides are two series of chemically similar metals. They are usually shown as two separate rows at the bottom of the periodic table for the ease of printing the periodic table. All of the elements in the top row are lanthanides, and in the bottom row are the actinides. In general, they have high melting and boiling points.

As you know, the order of the periodic table reflects the arrangement of electrons in energy levels. Each element differs from the one before it by having one more electron. As you move along the periodic table, electrons generally fill higher energy levels. The arrangement of the electrons is what give the elements their chemical properties. The lanthanides are similar to each other because their highest occupied energy level has the same arrangement of electrons. They are unusual in the fact that they have a lower energy level holding the extra electrons that make them different from on another.

The lanthanides used to be called “rare earth metals” but are no longer considered rare. They are used in alloys and most have magnetic properties. The strongest magnets are made of an alloy that includes cobalt (Co) with samarium (Sm).

The actinides are also similar to one another. All actinides are radioactive and some decay so quickly they must be made synthetically just to be studied. The best known actinide is uranium which is used in nuclear weapons and reactors.

Review Questions

Review the information you have been given about non-metals. Read the following questions and fill in the blanks **to the right** using the correct answer.

1.The Strongest magnet is made of cobalt and _____ a._____

a) La b) Sm c) Eu d) Yb

2. The _____ used to be called “rare earth metals” b._____

a) Lanthanides b) Metals c) Actinides d) Transition Metals

3. The best known _____ is uranium c._____

a) Lanthanide b) Metal c) Actinide d) Transition Metal

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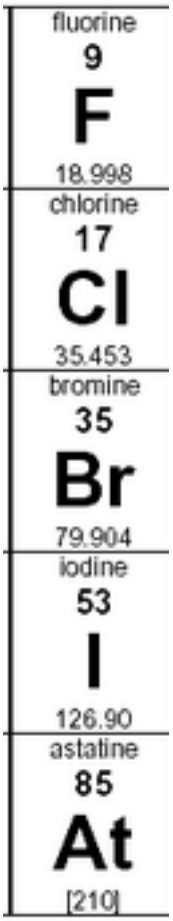
HALOGEN GROUP



When we think of salt we usually think of table salt or sodium chloride (NaCl). Sodium chloride is made or metal sodium (Na) and a halogen, chlorine (Cl). Table salt is actually just one of many salts. Whenever a metal is combined with a member of the halogen group 7A (17), a salt is formed. The halogen groups contains fluorine (F), chlorine (Cl), bromine (Br), iodine (I) and astatine (At). Group 7A (17) elements all have seven valence electrons.

In nature, halogens occur only in combinations with other elements. Pure Halogens are very poisonous. Halogens form ionic bonds with metals and Covalent bonds with non-metals. As gases, the halogens exist as diatomic molecules, which means they always come in pairs. Halogens have low melting points and low boiling points. They have densities that are greater than the air.

Of all the elements, fluorine is the most reactive. It is commonly found in the Mineral fluorite (CaF_2). Compounds containing fluorine are called fluorides. The most abundant halogen is chlorine, it is almost as reactive as fluorine. Chorine is used in disinfectants and bleaches. Bromine is the only non-metal that is liquid at room temperature. It has a reddish-brown color. Iodine has many properties that metals have, it is essential for human health. Lack of iodine can cause thyroid disorders. Astatine, one of earth's rarest elements is radioactive.

Review Questions

Review the information you have been given about non-metals. Read the following questions and fill in the blanks **to the right** using the correct answer.

1. The most abundant halogen is? a._____
a) fluorine b) bromine c) chlorine d) iodine

2. Of all the elements the most reactive is? b._____
a) fluorine b) bromine c) chlorine d) iodine

3. A halogen and a metal combine to form a _____. c._____
a) covalent compound b) ion c) salt d) gas

4. The only nonmetallic liquid at room temperature is _____. d._____
a) fluorine b) bromine c) chlorine d) iodine

5. Lack of _____ causes thyroid disorders. e. _____
a) fluorine b) bromine c) chlorine d) iodine

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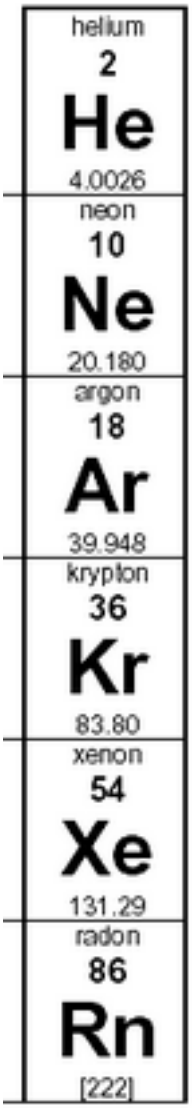
NOBLE GASES



The noble gases are member of Group 8A (18) on the periodic table. They include helium (He), neon (Ne), argon (Ar), krypton (Kr) and xenon (Xe). The noble gases are very unreactive and are all found freely in nature. They do not usually combine with other elements or with one another, but there are a few compounds that can be formed with the noble gases.

Noble gases are monatomic meaning that they are always found alone. The melting points, boiling points and densities have a wide range.

Helium is the second most abundant element in the universe. Only hydrogen is more abundant. The energy of the stars and of the hydrogen bomb come from the fusion of hydrogen into helium. Lighter than air and safer than hydrogen, helium is used to fill balloons and blimps. It is used also as a commercial refrigerant and in nuclear reactors. Neon is an even better refrigerant.

Neon, argon, and xenon were discovered by cooling air into a liquid and then separating the liquid into individual elements. Neon's largest use is in advertising signs. Most noble gases are used in advertising signs and produce unique bright colors. Most noble gases are also used in lasers.

The wavelength of the light produced by krypton has been used to define the international standard of the meter. Krypton is used in electron tubes, stroboscopic lights and bacteria killing lamps. Radon is the most dense of all gases and is given off when radium decomposes. Radon is also used in cancer treatment.

Review Questions

Review the information you have been given about metals. Read the following questions and fill in the blanks **to the right** using the words below, not all answers will be used.

Argon	hydrogen	neon	diatomic	krypton
Helium	radon	monatomic	unreactive	xenon

In general, the noble gases are chemically ___a___. a._____
In nature they are___b___ molecules rather than diatomic like the halogens.
b._____
___c___ is the second most abundant element in the universe. c._____.
The wavelength of light of__d___ has been used to define the international standard of the meter. d._____
__e___ has the highest density of all gases. e._____

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